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Fooled by Search: Housing Prices, Turnover and Bubbles*

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Abstract

Theory predicts that the effects of search frictions on house prices from temporary movements in demand should be temporary, while the data suggests it is permanent. The latter implies that movements in demand coupled with search frictions create higher volatility in prices than theory would predict, amplifying price changes, leading to bubbles and depressions. To generate permanent price changes from temporary demand shocks, a textbook search model is combined with a behavioral assumption where house buyers and sellers ignore the effects of search frictions on past prices. The estimated model implies that over half of the real price growth from the housing bubble starting in 1998 is due to the behavioral assumption where households are ‘Fooled by Search.’ When trend growth of prices is removed, the behavioral assumption explains almost three-fourths of the housing bubble.

The estimated model also provides several other results. (1) There is a large inefficiency in the search process of the housing market: buyers have very little bargaining power relative to their impact on creating sales, *i.e.* the Hosios condition is not met by an order of magnitude. (2) There is evidence of a rise in the fundamental value of houses from 1998 to 2005 that mirrors the loose monetary policy under the Greenspan Federal Reserve. (3) Analysis of the boom and bust of the housing market from 1975 to 1982 suggests that buyers who are choosing to *not* enter the housing market are rational. Using the last observation to make a back of the envelope projection for the current crisis, turnover will have to fall to its 1982 level and remain there until 2011 before a recovery can begin, driving house prices down to their real levels of 2002-2003.

Keywords: House Prices, Search, Turnover, Bubbles.

JEL Classification: F34, G20

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1 Introduction

In the housing market, people just do not know how to judge the overall level of prices. Much more salient in their minds is the rate of increase of prices.

Robert J. Shiller *Irrational Exuberance*, 2nd Ed., 2005. p. 208

Theory predicts that the effects of search frictions on house prices from temporary movements in demand should be temporary, while the data suggests it is permanent. The latter implies that movements in demand coupled with search frictions create higher volatility in prices than theory would predict amplifying price changes, leading to bubbles and depressions. To generate permanent price changes from temporary demand shocks, a textbook search model is combined with a behavioral assumption where house buyers and sellers ignore the effects of search frictions on past prices. The estimated model implies that over half of the real price growth from the housing bubble starting in 1998 is due to the behavioral assumption where households are ‘Fooled by Search.’ When trend growth of prices is removed, the behavioral assumption explains almost three-fourths of the housing bubble. Furthermore, the estimated model implies that there is a large inefficiency in the search process of the housing market: buyers have very little bargaining power relative to their impact on creating sales, *i.e.* the Hosios (1990) condition is not met by an order of magnitude.

Search theory models the difficulties with which buyers and sellers have in finding, or ‘searching’ for each other, in order to make a trade. These difficulties are the ‘search frictions’ that are without a doubt present in the housing market.¹ An increase in relative demand, defined as the number of buyers to sellers, or market tightness, makes it easier for a seller to find a buyer. This raises the amount of sales and it also raises the price, since sellers know that it is easier to find another buyer—the search frictions for sellers have decreased. Search theory thus predicts a positive relationship between sales (or turnover²) and prices when shocks to demand drive the market.³ However, search theory, like standard Walrasian Theory, predicts that demand should be related to the price level.

We now arrive at Shiller’s quote. Shiller states that the market participants in the housing market “just do not know how to judge the overall level of prices.” Figure 1 is essentially Shiller’s quote put into graphical form. The immediate striking feature is the tremendously high real house price level around 2005. The high price level is the housing bubble that is at the heart of the current troubles of the economy as well as the ‘Irrational Exuberance’ that is the topic of Shiller’s prophetic text. Shiller states in two paragraphs before the opening quote that

¹Search frictions, along with transactions costs have often been argued to explain the inefficiency in the housing market documented by Case and Shiller (1989).

²Turnover is simply sales normalized by the stock, in this case the stock of homes.

³Note that increases in supply would raise turnover and *lower* prices, creating a negative correlation between turnover and house prices.

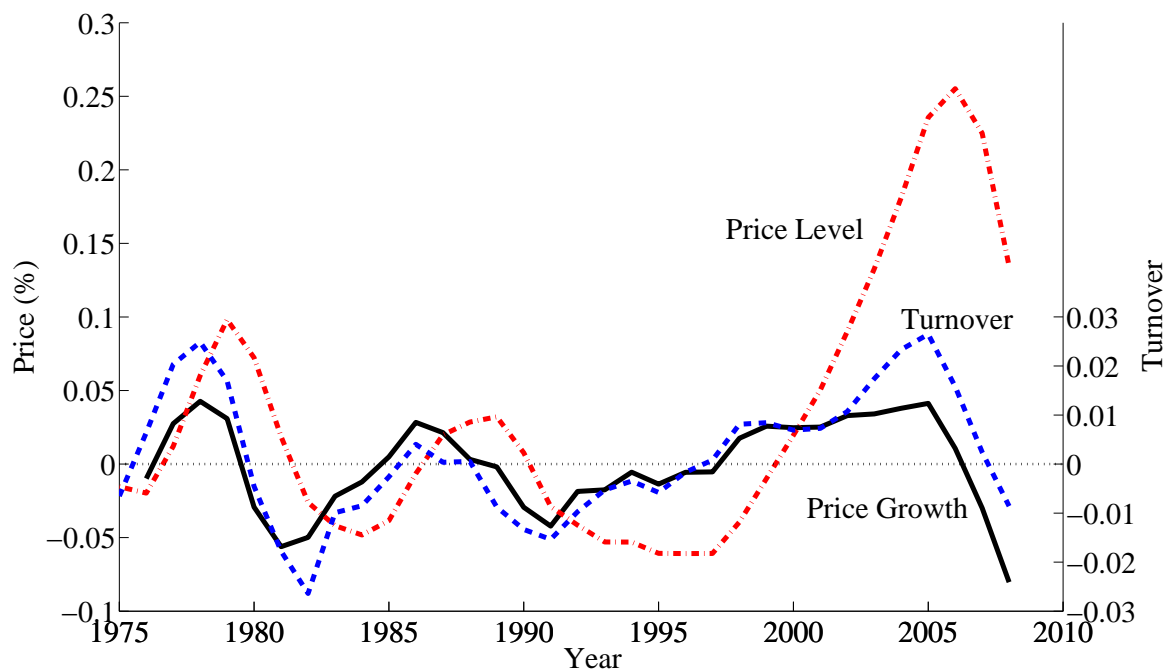


Figure 1: **Annual Real House Price Growth, Annual Detrended Real House Price Level and Turnover** Both the house price growth and turnover are deviations from means. The real price level is the percent deviation from a log-linear trend. The left scale is for prices, while the right is for turnover. The years 1976 to 2003 were used to calculate the means and the log-linear trend. The data is made real by deflating by the GDP Deflator. Source: OFHEO, BEA, NAR and Census SOC and CPS/HV.

The housing market levels we have seen recently are not, as so many imagine, the outcome only of fundamental forces affecting the rational demand for and supply of housing.

He believes that something non-fundamental is driving the irrationally high house prices. But he does go on to state that “of course home prices are set by the forces of supply and demand, ...the prices have to clear the market.” In figure 1 we can see quite clearly the laws of supply and demand at work. Turnover, defined as house sales⁴ over the total owner housing stock⁵ moves very closely with real housing price growth. The correlation of the two series is 0.89 and the R^2 from a simple OLS regression of price growth on turnover is 0.79.⁶ It appears that movements in housing demand cause both sales to increase and prices to rise. It would seem at first glance that fundamental forces are indeed working quite well.

But, as stated above, and to be fleshed out further below, theory predicts a relationship between turnover and the price level, not price growth. The data are not friendly to the theory. We easily see in figure 1 that turnover moves with price growth not the price level. Note that this is not an implication from the relative magnitudes of the curves, rather, it is the difference in the timing of the peaks and valleys of the curves: the price level lags turnover, while price growth and turnover move together.

The data imply that a temporary increase in turnover above its long-run level raises prices *permanently*. Furthermore, a permanent increase in turnover results in a permanent increase in the growth rate of prices. To see this in the data, in figure 1, examine the period from 1998 to 2002. We see that turnover rose above its long-run level and stayed there for three years. In those same years we see an approximate permanent change in the growth of detrended prices from zero, being on trend, to something much larger. We are getting a disagreement between theory and data. Theory predicts that demand should affect the price level while the data say demand affects price growth.

This confusion between growth in prices and the price level is Shiller’s observation in his quote at the start of this paper. People seem to have very little idea about what price levels should be. Instead they seem to have a much better idea about what should be happening to price growth, or in Shiller’s words, ‘the rate of increase of prices.’

Theory can be reconciled with data by assuming that current market participants are indeed affected by search frictions in setting prices, but when trying to elucidate the ‘fundamental’ from past prices, they ignore the effect of search frictions on past prices. In other words, households have a difficult time understanding and interpreting what the price level means. They ignore that the past price level may have been high due

⁴Both new and existing, single family.

⁵Consists of owner-occupied houses and vacant houses for sale from the Census Housing Vacancy survey which is a part of the CPS.

⁶This high explanatory power of turnover for price growth is mentioned in footnote 5 in Ortalo-Magné and Rady (2006) and by Wheaton at the 2009 annual meetings in a presentation of a revision of Wheaton and Lee (2008).

to a combination of search frictions and past high demand. Instead, they are fooled into thinking that there has been a permanent change in the value of a house. Under this assumption, buyers and sellers bargain over the price level *relative* to past prices, regardless of what past demand was.⁷ As a result, buyers and sellers bargain over price growth not the price level. The price change that is then induced by current demand and search frictions, goes on to become permanent from future market participants ignorance of past search frictions on prices.

The behavioral inefficiency is introduced into a textbook search model with bargaining. The model consists of a stationary set of buyers and sellers. A house is simply an asset from which buyers derive utility and sellers can produce at zero cost. There is a fundamental value to the house that determines the lifetime utility that buyers receive from owning the asset, however, the level of the fundamental value is unknown. The model assumes that buyers and sellers determine the fundamental value of a house from past prices. However, a behavioral inefficiency is introduced where, when calculating the fundamental value of a house from past prices, buyers and sellers irrationally ignore that past prices are influenced by search frictions. A stationary version of the model is linearized generating a linear relationship between price growth and turnover. The model is estimated using standard OLS where each annual observation in the data from 1975-2007 is treated as an independent observation of the stationary model. The argument is that from week to week, buyers and sellers in the housing market treat the measure of buyers to sellers as essentially fixed. There is no modelling of the entry decision of buyers and sellers. The estimated model explains 78.77% of the annual movements in house price growth and 80.35% of the movements in the detrended house price level.

From the estimated model, counterfactuals can be generated where the behavioral inefficiency has been removed. Figure 2 plots the realized house price level from 1998 (normalized by the 1998 price), along with the counterfactual and the trend price level.⁸ In the data, house prices peaked in 2006, after having appreciated 45.26% since 1998. In the counterfactual, house prices peak one year earlier, in 2005, only having appreciated 21.41%. This implies that the behavioral inefficiency caused prices to rise an extra 23.84%, or 52.67% of the total increase. In other words, the behavioral inefficiency explains over half of the house price bubble. When the trend growth of prices is removed, the data peaks at 25.19% above trend, while the counterfactual peaks at 6.93% above trend. Relative to the trend the inefficiency explains 72.48%, or almost three-fourths, of the bubble.

Note that the model is not explaining the cause of the bubble.⁹ The ultimate cause lies in the reasons that turnover increased so much. Rather, the mechanism is only an

⁷The efficient markets theory, Fama (1970), can be thought of as rationalizing buyers' and sellers' use of past market prices as a signal of the fundamental value. Behavioral economics, Tversky and Kahneman (1974), then argues that buyers and sellers use the past market prices as an anchor in their negotiating.

⁸The trend is based upon average annual growth from 1976 to 2003.

⁹For an overview of bubbles see Kindleberger's *Manias, Panics and Crashes* and Shiller's *Irrational Exuberance*. For an overview of theoretical modelling of bubbles see Brunnermeier (2008).

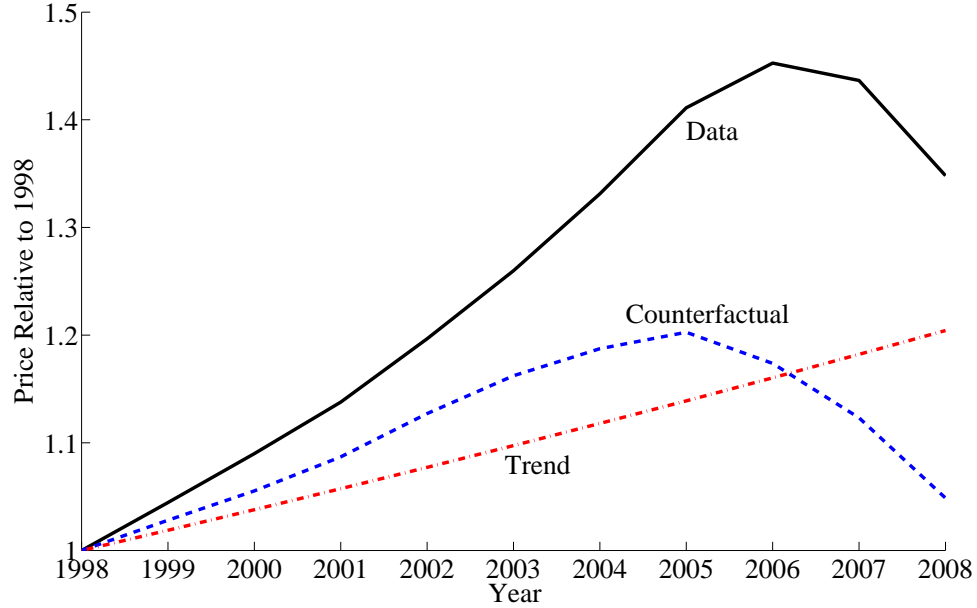


Figure 2: **Housing Bubble** Annual Real House Price Level: Data, Counterfactual from Estimated Model where Irrational Assumption has been removed, along with estimated trend. Data Source: OFHEO.

amplification device given the observed path for turnover. However, Shiller hypothesizes in *Irrational Exuberance* that households respond to changes in growth rates, creating positive feedbacks. The behavioral inefficiency here causes what should be level effects to become growth effects, which then can cause positive feedback into turnover under Shiller’s hypothesis.

The estimated model has three other interesting results. First, the underlying search process in the housing market is inefficient. As stated by Hosios (1990), the efficiency condition for a search model is that the weight on buyers in the matching function should be equal to the bargaining weight on buyers.¹⁰ Essentially, the ‘Hosios Condition’ equates the social return of a buyer searching, given by how the buyer’s action contributes to creating a match, to the buyer’s private return. Given the estimate of the model, in order for the search model to be efficient (ignoring the inefficiency from the behavioral assumption) households have to discount the future at an annual rate of, at a minimum, over 40%. Such a high level of impatience seems implausible, so that the search frictions in the housing market are inefficient by an order of magnitude.

Second, the estimated model identifies an increase in the fundamental value of housing starting in 1998, peaking in 2003-2005, and then falling back down to its 1998 level by

¹⁰That is, the bargaining weight from the generalized Nash Solution, which is used in the model to represent the bargaining between buyers and sellers.

2007. This time period roughly coincides with the period of relatively loose monetary policy under the Greenspan Federal Reserve. It is after this rise that we see turnover really take off in the housing market. In a rational model, the increase in turnover should have only caused a slight increase in the price level relative to trend (only approximately 7%). But to the contrary, the estimated irrational model implies that that households take the temporary rise in turnover and treat it as permanent, so that as turnover remains high, prices keep on rising. In essence, the irrational assumption is an amplification effect that magnifies the effect of the loose monetary policy on house prices. It is the irrationality inefficiency that potentially makes the error in monetary policy be quite painful.

Third, examination of the 1975-1982 boom and bust in the housing market suggests that the buyers who are choosing to not enter the housing market are behaving somewhat rationally. In comparing the counterfactual price level with the price level in the data, we see that whenever the counterfactual price is above the price in the data, that turnover is increasing. However, once the counterfactual price falls below the price in the data, turnover falls, and keeps on falling until the price in the data is driven down to the counterfactual price. This suggests that potential buyers do respond to the price level. They understand when prices are overvalued and remain out of the market until prices fall.¹¹

We can use the results from the 1975-1982 housing market to make a projection for the current housing crisis. In the estimated model, the counterfactual price was above the price in the data until 2004.¹² It is then in 2005 that turnover peaks as the counterfactual starts to fall below the price in the data. Ever since then, turnover has been falling, as the price in the data has remained above the counterfactual price. As turnover remains low, the price in the data will fall more than the counterfactual. We can then ask the question: what paths for turnover can drive the price in the data down to the counterfactual? The answer to that question can give a prediction for how severe and long we can expect the housing crisis to be. I first show that a bust of the same size of the 1982 bust in housing will not deliver this. I then show that turnover falling to the lowest level of the 1982 bust and remaining there for 2009-2011, will deliver the result. Therefore, a back of the envelope calculation using the estimated model suggests that there are a couple more years of very depressed activity in the housing market. The model predicts that once prices stop falling they will have fallen back to their real levels in 2002-2003. Of course, nominal values may be more important, but that depends upon what happens to inflation or deflation.

A word about the significance of the results, the main result of the paper is the very high correlation between house price growth and turnover. This restriction should be thought of as litmus test for housing models that attempt the much harder and nobler task of endogenizing turnover and prices. As is covered in a separate section later in this

¹¹This suggest informed and uninformed agents as in the model of a bubble by Abreu and Brunnermeier (2003).

¹²Note that the counterfactual includes the estimated shock to the fundamental value of a house from 1998-2005 that is potentially attributed to the Greenspan Fed.

paper, without endogenizing turnover, there is no way to distinguish the irrational model from a rational model where deviations in turnover from the long-run mean are correlated with permanent changes in the value of a house. Additionally, regional, metropolitan and other countries' data need to be analyzed to uncover the robustness of the high correlation between turnover (or any measure of a sales rate) and price growth.

The strong relationship between turnover and prices was first illustrated in Stein (1995). Subsequently, papers by Berkovec and Goodman (1996), Ortalo-Magné and Rady (2004), Andrew and Meen (2003), Leung, Lau and Leong (2002) and Wheaton and Lee (2008) have confirmed the results. None of these papers focuses on the difference between the price level versus price growth.¹³

One line of thought to explain the relationship between turnover and sales is the search context used in this paper. The first search model of housing is Wheaton (1990). The model in Williams (1995) is very close to the model in this paper, and is the first paper to consider aggregate uncertainty. Since then several papers have developed search models to explain the general relationship, notably, Berkovec and Goodman (1996), Krainer (2001), Novy-Marx (forthcoming), Leung and Zhang (2007), Ngai and Tenreyo (2008) and Díaz and Jerez (2008). With the exception of Ngai and Tenreyo (2008) and Díaz and Jerez (2008), none of these papers confront the empirical predictions of the model with the data. None of these papers examines the implications for the model regarding the relationship between turnover and price growth versus price levels. The paper by Berkovec and Goodman (1996) is very interesting, sharing similar features to the irrational model in this paper, such as a backward looking element for price setting similar to this paper. However, they assume an equation for the slow adjustment of prices, not placing it in a microfounded theory of why prices are backward looking. Furthermore, they assume that sellers do not know the current level of market tightness. Last, the paper by Albrecht, Anderson, Smith and Vromer (2007) shares several modelling features with the model of this paper, but they look at the implications of impatient buyers and sellers on price dispersion and time on the market in a stationary environment.

Another idea besides search frictions to explain the high correlation between turnover and prices,¹⁴ first put forth by Stein (1995), is that households face a down payment constraint to buy a home. When prices fall, current homeowners have less equity that they can then apply to buy a bigger house, so that turnover also falls. This idea has been quite nicely put into a dynamic OLG setting by Ortalo-Magné and Rady (2006).¹⁵ Several authors have been taking the search and the credit constraint theories and tried to see which is more important.¹⁶ I do not see these theories as competing, rather, they

¹³Wheaton and Lee (2008) have mentioned the difference, but their inclusion of lags in their estimation of levels makes a model in levels equivalent to a model in differences.

¹⁴Also put forth by Genesove and Mayer (2001) and Engelhardt (2003) is nominal loss aversion. In this case, in a downturn, sellers are reluctant to sell and face nominal losses, so turnover falls.

¹⁵Further work by Sanchez -Marcos and Ríos-Rull (2007) has tried to extend the environment of Ortalo-Magné and Rady (2006).

¹⁶See Leung, Lau and Leong (2002), Wheaton and Lee (2008) and Clayton, Miller and Peng (forthcom-

reinforce each other: prices drive turnover and turnover drives prices. In my opinion, a model that combines both of these frictions is much closer to reality than a model with only one such friction.

The rest of the paper is laid out as follows. First, the simple rational search model is presented. This is followed by a discussion of the data that is used in estimating the model. The rational model is then estimated, show the lagging behavior of the price level to turnover. Next the Irrational model is presented where there is the behavioral inefficiency. The Irrational model is then estimated, showing the very good fit between turnover and price growth. The Rational and Irrational models are then compared. This is followed by a discussion of the comparison between the Irrational model and a Rational model where the deviation of turnover from its mean is related to a permanent shock to the value of a house. There is no way in the data to distinguish these two models from each other. The implications of the estimated model are then covered. First the inefficiency in the search process is covered. This is followed by the counterfactuals for the housing bubble from 1998-2006, the estimated shock to the fundamental value of a house during the years of the loose monetary policy under Greenspan, and then the boom and bust in the housing market in 1975 to 1982. Finally, projections are made for the current housing crisis. The last section concludes.

2 Simple Fully Rational Model of Search

2.1 Non-Stochastic Stationary Model Environment

First consider a fully rational stationary model without aggregate uncertainty, holding all variables fixed. There are two types of agents: *buyers* and *sellers*. Time is continuous and all agents discount the future at rate r . Denote the constant measure of buyers as μ_B and of sellers as μ_S .¹⁷ Let y denote the constant expected present discounted value to a buyer from buying the asset. As detailed below, buyers and sellers meet randomly to trade the asset at an endogenous price p . The flow utility to the seller from possessing the asset is normalized to zero.¹⁸

The number of matches per unit time between a buyer and a seller is given by the matching function

$$m = m(\mu_B, \mu_S).$$

The arrival rate of a buyer for a seller, or the selling rate, is

$$s = \frac{m(\mu_B, \mu_S)}{\mu_S}.$$

ing).

¹⁷No attempt is made in this paper to model the entry decisions of buyers and sellers. Instead, the focus is on pricing. However, the later counterfactual results do add insight into to how the entry of buyer and sellers should be modelled.

¹⁸This is a normalization. The flow value to a seller could be made positive and the flow value of a buyer could be modified to give the same results.

Denote the finding rate of an asset for a buyer as

$$f = \frac{m(\mu_B, \mu_S)}{\mu_B}.$$

Let θ denote the ratio of buyer to sellers, or market tightness. Further, assume that the matching function exhibits constant returns to scale. We can then write the selling and finding rates as

$$s = m(\theta, 1) = s(\theta)$$

and

$$f = \frac{1}{\theta} s(\theta).$$

Last, assume that

$$s(\theta) - \theta s'(\theta) > 0.$$

This restriction is a sufficient condition to ensure that prices are increasing in the ratio of buyers to sellers.

The value function for a buyer is

$$rV_B = f(y - p - V_B), \quad (1)$$

while that of a seller is

$$rV_S = s(p - V_S), \quad (2)$$

where the dependence of s and f on θ has been suppressed to ease on notation. These value functions imply that when a buyer and seller make a trade, they never trade again. To keep the measure of buyers and sellers stable, assume that a succesful buyer and seller are immediately replaced with another buyer and seller.

When a buyer and seller meet they bargain over the price \hat{p} . Here we denote \hat{p} as the price buyers and sellers bargain over, taking prices in potential future matches, p , as fixed. Assume that the bargaining process can be represented as the solution to a Nash bargaining problem. The threat point for a buyer is to continue being a buyer, implying a surplus to the buyer of

$$S_B = y - \hat{p} - V_B.$$

The threat point for a seller is to continue being a seller, giving a seller a surplus of

$$S_S = \hat{p} - V_S.$$

The total surplus to the trade, $S = S_B + S_S$, is given by

$$S = y - V_B - V_S.$$

Let ω be the bargaining power for a buyer. The price setting equation from the Nash solution satisfies

$$S_B = \omega S,$$

which is given by

$$y - \hat{p} - V_B = \omega [y - V_B - V_S].$$

Doing some re-arranging, we arrive at the following price setting equation

$$\hat{p} = (1 - \omega) (y - V_B) + \omega V_S. \quad (3)$$

A stationary equilibrium is thus p , \hat{p} , V_B and V_S that satisfy equations (1)-(3) and

$$\hat{p} = p. \quad (4)$$

2.2 Stationary Model Solution

Solving for V_B and V_S from equations (1) and (2) we get

$$V_B = \frac{f}{r + f} (y - p)$$

and

$$V_S = \frac{s}{r + s} p.$$

Inserting these into the pricing equation and setting $\hat{p} = p$ we get

$$p = (1 - \omega) \left(y - \frac{f}{r + f} (y - p) \right) + \omega \frac{s}{r + s} p.$$

Re-arranging

$$p = (1 - \omega) \frac{r}{r + f} y + (1 - \omega) \frac{f}{r + f} p + \omega \frac{s}{r + s} p.$$

Putting in the dependence of s on θ and using the substitution $f = s(\theta)/\theta$ we arrive at the equilibrium pricing equation of

$$p(\theta) = \frac{r + s(\theta)}{r + s(\theta) + \omega s(\theta) (1/\theta - 1)} (1 - \omega) y. \quad (5)$$

It is trivial to show that the price is increasing in the measure of buyers to sellers. Taking the derivative with respect to θ in equation (5) gives

$$p'(\theta) = \frac{(s(\theta))^2 + r\theta^2 s'(\theta) + r[s(\theta) - \theta s'(\theta)]}{\theta^2 [r + s(\theta) + \omega s(\theta) (1/\theta - 1)]^2} \omega (1 - \omega) y. \quad (6)$$

Since $s'(\theta) > 0$ and $s(\theta) - \theta s'(\theta) > 0$, prices are increasing in the measure of buyers to sellers.

2.3 Further Model Assumptions and Approximation

This subsection and the next subsection modify the model in order to bring the model to the data. The empirical strategy that will be employed later is to treat each annual observation as a stationary observation of the continuous time model. That is, each annual observation is treated as a steady-state observation where market tightness, θ , and the fundamental value to owning a house, y , are treated as constants. With the understanding that we will be using the stationary model solution in the future estimation, this subsection then modifies the model in order to make an approximation to the stationary model.

The first modification of the model is to make a simplifying assumption on the matching technology.

Assumption 1. The matching function is Cobb-Douglass, given by

$$m(\mu_B, \mu_S) = A\mu_B^\alpha \mu_S^{1-\alpha}.$$

This assumption is standard in the labor search literature. Empirical work in labor search has failed to reject a constant returns to scale matching function,¹⁹ while little justification has been given for the Cobb-Douglass functional form.²⁰ To the author's knowledge this issue has not been addressed in the housing search literature. Under this assumption, the selling rate is

$$s(\theta) = A\theta^\alpha.$$

The next modifications create a point around which to approximate the price for the empirical analysis. First, assume that market tightness is on average unity.

Assumption 2. On average, market tightness is unity, or

$$\bar{\theta} = 1.$$

This is essentially an identifying assumption²¹ for bringing the model to the data. The idea is that, in the long run, the measure of buyers is approximately equal to the measure of sellers.

The last modification is to write the fundamental value to owning a house at time period t as

$$y_t = e^{z_t} \bar{y}_t$$

where z_t can be thought of as a deviation of the fundamental value of a house from a long-run trend \bar{y}_t . The following assumptions are made about the behavior of z_t and \bar{y}_t .

Assumption 3. On average $z_t = 0$ and \bar{y}_t grows at a constant rate γ so that

$$\bar{y}_t = (1 + \gamma) \bar{y}_{t-1}.$$

¹⁹See the survey by Petrongolo and Pissarides (2001)

²⁰See Shimer (2005).

²¹Note that this is indeed an identifying assumption and not a normalization. Inspection of equations (5) and (6) shows that this assumption affects the relationship between r , s and p .

For now no attempt is made to model a process for z_t except that it has mean zero.

These last two modifications allow for a definition of the stationary price at time t as depending upon θ_t and z_t . From equation (5) we get

$$p_t(\theta_t, z_t) = \frac{r + s(\theta_t)}{r + s(\theta_t) + \omega s(\theta_t)(1/\theta_t - 1)} (1 - \omega) e^{z_t} \bar{y}_t. \quad (7)$$

Define \bar{p}_t as the stationary price level when $\theta_t = 1$ and $z_t = 0$. From equation (7) we get

$$\bar{p}_t = (1 - \omega) \bar{y}_t. \quad (8)$$

Doing a Taylor series approximation for $p_t(\theta_t, z_t)$ around $\theta_t = 1$ and $z_t = 0$, we get

$$p_t(\theta_t, z_t) \approx \left[1 + \frac{A}{r + A} \omega (\theta_t - 1) + z_t \right] \bar{p}_t \quad (9)$$

where the condition $s(1) = A$ has been inserted. Equation (9) is the central equation that will serve as the basis for the later estimations.

3 Data

This section documents the data that is used in estimating the model.

3.1 House Prices

Figure 3 plots the annual real house price since 1975, where the 1975 price has been normalized to one. The series for house prices is the price index put forth by the Office of Federal Housing Enterprise Oversight (OFHEO) divided by the GDP Deflator from the Bureau of Economic Analysis (BEA).²² Figure 4 plots the annual real house price appreciation (the 2008 observation is an annualized number from the first three quarters of 2008). The price appreciation series appears stationary with a mean of 1.81%.²³

3.2 Turnover

For turnover I construct a measure of total sales relative to the owner stock of housing, which I define below.

²²The OFHEO produces their price index from Fannie Mae and Freddie Mac conforming mortgages. There are two indices. One consists of purchase only mortgages, the other consists of all transactions including refinances. The all transactions index goes back to 1975 while the purchase only index goes back to 1991. The series used in this paper is a combination. From 1975 to the first quarter of 1991 the all transactions index is used. From the second quarter of 1991 on the purchase only index is used. The purchase only index is slightly smoother in quarterly data, as is evident by the smoother series after 1991 in figure 3.

²³This stationarity was not so obvious before the current downturn, a nice positive externality of the current problems. The 1.81% includes the annualized observation from the first three quarters of 2008.

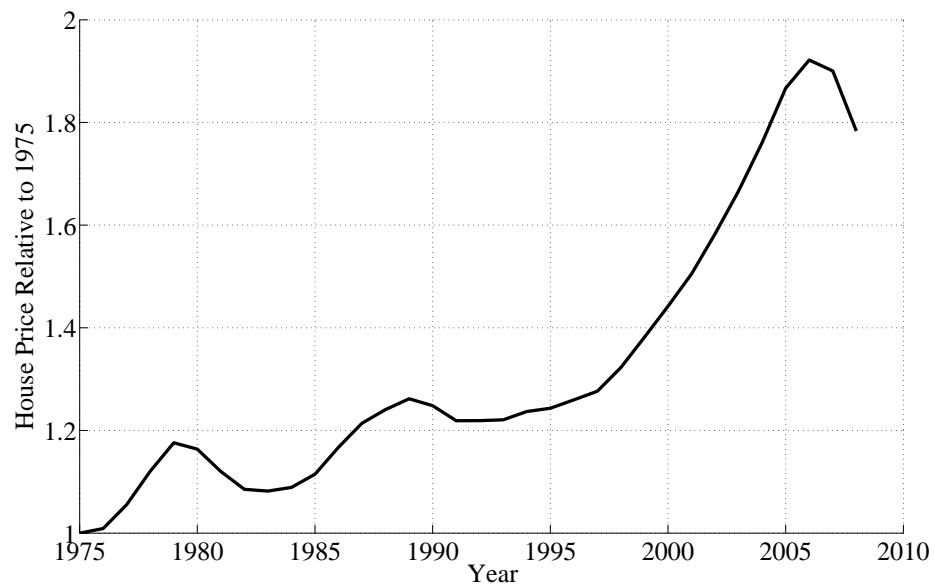


Figure 3: Annual Real House Price normalized by 1975 real house price. 2008 is annualized numbers for first three quarters Source: OFHEO and GDP Deflator.

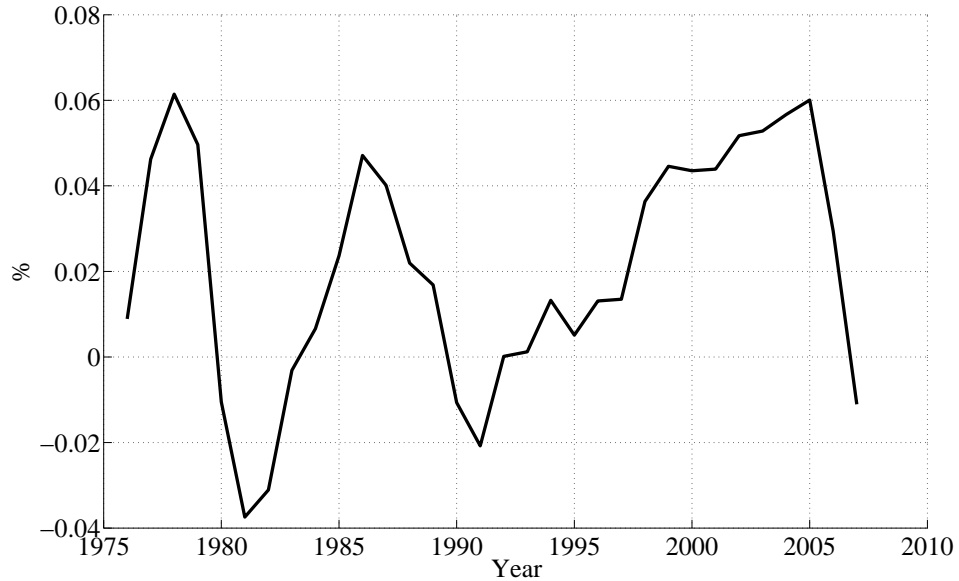


Figure 4: Annual Real House Price Appreciation, 2008 is annualized numbers for first three quarters. Source: OFHEO and GDP Deflator.

Owner Stock of Housing As part of the Current Population Survey, Census also surveys structures and constructs a quarterly series for housing units referred to as the Housing Vacancy Survey. They break down housing units into owner-occupied, renter-occupied, vacant for sale, vacant for rent, and several other variables such as vacation and second homes. I define the owner stock of housing,^{24,25} or simply the owner stock, as

$$\text{owner stock} = \text{owner occupied housing} + \text{vacant houses for sale} .$$

Sales For sales data I combine two series. The first is the existing home series published by the National Association of Realtors (NAR). This series is reported monthly beginning in 1968. The other series is the new homes sales as reported by the Census Bureau in the Survey of Construction (SOC). This series is also reported monthly, but starts a bit earlier in 1963. Both series are for single family units.²⁶ I define *total sales* as the combination of the two and aggregate them quarterly at an annual rate.

Turnover Let turnover be the ratio of total sales to the owner stock. Figure 5 plots this ratio annually, beginning in 1968 when the existing homes sales data start. The series appears stationary with a mean of 7.09%. The mean rises slightly when the data before 1975 are excluded to 7.34%.

4 Estimation of the Rational Model

4.1 Data and Stationary Price

Make the following observation regarding the data and the stationary price of the model.

Assumption 4. Each annual observation in the data is an observation of the stationary price.

The idea is that the current buyers and sellers treat the current level of market tightness as essentially fixed. The model is about pricing behavior in decentralized trade. This trading is going on day to day, week to week. The level of market tightness is not adjusting fast enough to influence the pricing behavior of the current buyers and sellers.²⁷ Therefore, current buyers and sellers treat market tightness as fixed. In this spirit, each annual observation is treated as an observation of the stationary price.

²⁴The series is revised at each decennial census. For those time periods the Census Bureau reports two values. I reconstruct a consistent series using the growth rates, working backwards from the current period. Details are shown in the appendix.

²⁵The total stock of housing, including rental housing could also be used. It performs slightly worse in the estimation of the ‘Irrational’ Model later, only generating an R^2 of 74.63%. The main difference is the behavior of the data in the early 1980s when the homeownership rate was falling.

²⁶The data for existing sales of multi-family units begins much later.

²⁷This is not to say that the current level of prices may not influence the decision of potential buyers and sellers to enter the market. Indeed, later in the paper evidence is presented that potential buyers are indeed influenced by the price level.

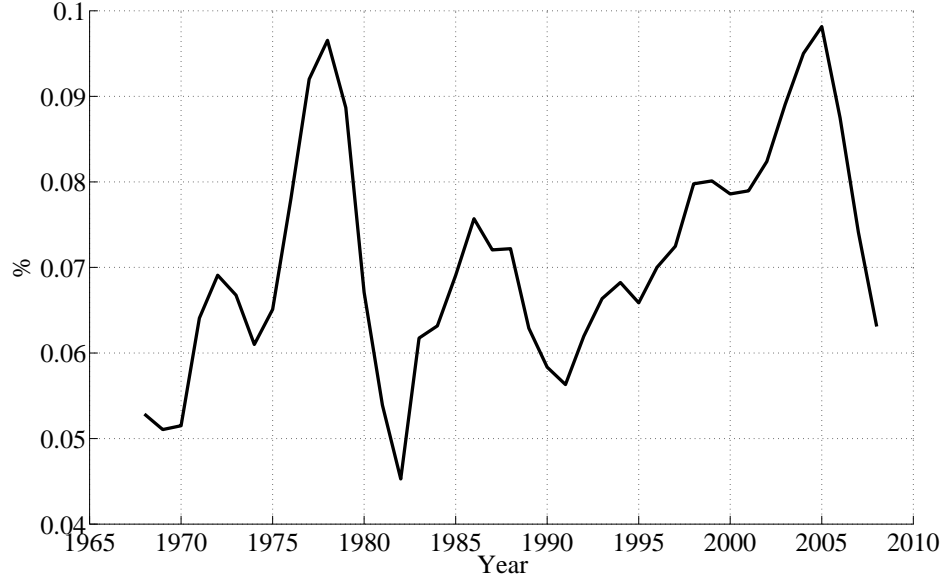


Figure 5: Turnover. 2008 is annualized numbers for first three quarters. Source: NAR and Census CPS/HV and SOC.

4.2 Turnover

To map the model into turnover, make the additional assumption that the measure of sellers, μ_S , is proportional to the owner stock, μ_O .²⁸

Assumption 5. The measure of sellers is proportional to the measure of the owner stock by the factor κ :

$$\mu_S = \kappa \mu_O.$$

This assumption allows the data on turnover to be mapped into market tightness. The assumption means that the true measure of homes for sale in the economy is proportional to the stock of housing, rather than the number of homes that are currently listed for sale.

From the definition of the matching function total sales is given by

$$sales = \mu_{SS}(\theta).$$

Define $\phi = sales/\mu_O$. Refer to ϕ as turnover. Using assumption 5 we get

$$\phi = \kappa s(\theta). \tag{10}$$

²⁸This paper originally started using the measure of homes for sale from the NAR and the new homes for sale in the Census SOC. It turns out that the total stock of housing fits the data much better. This difference is the subject of a note that the author is currently working on.

Using the Cobb-Douglass matching function, $s(\theta) = A\theta^\alpha$, implies that

$$\left. \frac{d\theta}{d\phi} \right|_{\theta=1} = \frac{1}{\alpha\kappa A}. \quad (11)$$

Furthermore, let $\bar{\phi}$ denote the value for ϕ when $\theta = 1$, or $\bar{\phi} = \kappa A$. Additionally, define

$$\hat{\phi}_t = \phi_t - \bar{\phi}$$

as the deviation of ϕ from $\bar{\phi}$.

Using equations 9 and 11 we get the following equation for the approximate relationship between the stationary price and the deviation in turnover at time t :

$$p(\hat{\phi}_t, z_t) \approx \left[1 + \frac{A}{[r + A]} \frac{\omega}{\alpha} \frac{1}{\bar{\phi}} \hat{\phi}_t + z_t \right] \bar{p}_t \quad (12)$$

Equation (12) is the central equation that we will use to test the rational model.

4.3 Estimation in Levels

The rational model is best estimated by examining the implications for the price level relative to trend. To see this, define

$$\hat{p}_t = \frac{p_t - \bar{p}_t}{\bar{p}_t}$$

as the percent deviation of the price level from the trend price level. From equation 12 we get

$$\hat{p}_t = \frac{A}{[r + A]} \frac{\omega}{\alpha} \frac{1}{\bar{\phi}} \hat{\phi}_t + z_t \quad (13)$$

Define

$$\psi = \frac{A}{[r + A]} \frac{\omega}{\alpha} \frac{1}{\bar{\phi}}. \quad (14)$$

We can then write equation (13) as

$$\hat{p}_t = \psi \hat{\phi}_t + z_t \quad (15)$$

Before estimating ψ , the series for \hat{p}_t must be constructed. In order to do this a stand must be taken on the trend price level. Using the whole data set from 1975-2007 may result in an upward bias of the trend growth rate since the data does not include all of the bust associated with the current boom and bust cycle. Along these lines assume that trend growth is equal to growth from 1975 to 2003. Note that this affects not only the average growth rate of prices, but also the value for the mean level of turnover, $\bar{\phi}$. Restricting the data for the estimation of trend growth lowers the trend growth rate of prices from 2.12% to 1.64% and $\bar{\phi}$ from 7.37% to 7.07%. The estimated deviation from trend is shown by the dark solid line in figure 6

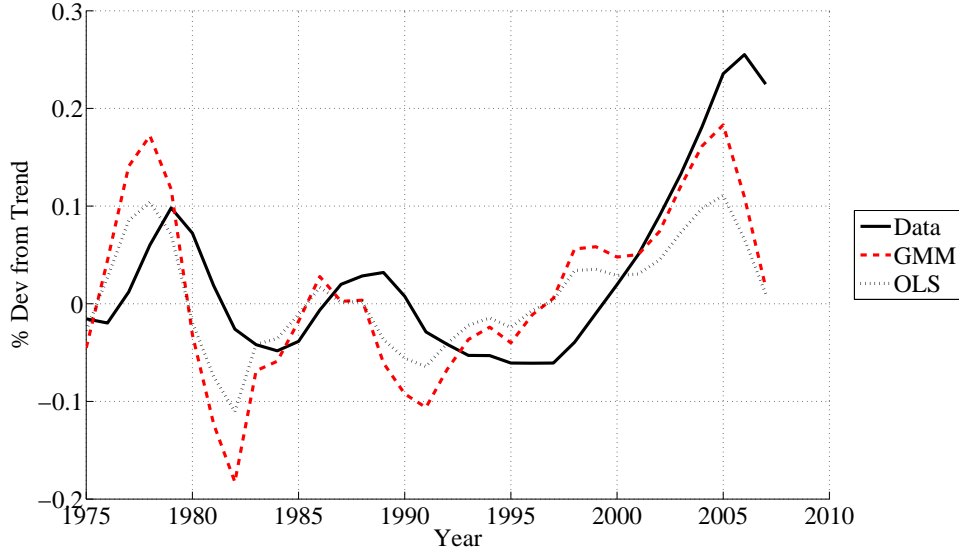


Figure 6: House Price Percent Deviation From log-linear trend, Data and Estimated Model. Source: OFHEO.

Turning to the estimation, the model is estimated using two methods. The first method is standard OLS. The second method is to use GMM and match the volatility of \hat{p}_t . Trivially, the GMM estimate for ψ is given by

$$\psi^{GMM} = \frac{std(\hat{p})}{std(\hat{\phi})},$$

the ratio of the standard deviations. The estimation results in

$$\psi^{OLS} = 4.1850 \quad \psi^{GMM} = 6.9164.$$

The fit is shown in figure 6. Both estimations do a fairly good job of fitting the data. As could be expected the OLS estimation does not create enough movement in prices. The failure is that in both estimations prices seem to lag turnover.

One interpretation is that prices are sticky and are slow to adjust to market conditions. Such an assumption implies that in the decentralized price setting between buyers and sellers, they behave as if market conditions were equal to last year's market conditions. It would seem that the current buyers and sellers would have more information about the current market conditions than last year's market conditions. Indeed, in the next section, the 'Irrational' Model is introduced where current buyers and sellers are very well aware of current market conditions but quite ignorant of past market conditions, instead assuming that past periods were average market tightness and interpreting prices as a indicator of the fundamental value of a house.

5 Irrational Model of Search

In the previous sections the fundamental value to owning a house was given by

$$y_t = e^{z_t} \bar{y}_t$$

where \bar{y}_t was the trend component and z_t was a deviation from trend. The ‘Rational’ Model of the previous sections assumed that current buyers and sellers²⁹ knew the deviation from trend. In this section we relax this assumption and instead assume that buyers and sellers infer it from past prices, plus some noise.

Modelling buyers and sellers inference of z_t from past data is a potentially daunting task. Here two simplifying assumptions are made. The interpretation of the assumptions is that current buyers and sellers do indeed make their inference of z_t using these assumptions. First, assume that z_t follows a random walk.

Assumption 6. Assume that z_t follows a random walk:

$$z_t = z_{t-1} + \varepsilon_t.$$

Further, assume that current buyers and seller observe ε_t but not z_{t-1} .

The random walk assumption implies that buyers and sellers think shocks to the fundamental value of a house are permanent. Note that this is a permanent shock to the *level* of the value of a house, not a shock to the *growth rate* of the level of a house. The assumption that ε_t is observed but that z_t is not seems a bit contradictory. It can be thought of this way: buyers and sellers observe fundamentals such as down payments and interest rates; they know that the fundamentals affect the value of a house; however, they do not know the level of a value of a house, just how the fundamentals affect the *change* in the level. An analogous environment from growth theory is knowing the change in TFP, but not the level.

This assumption means that households should use the previous year’s price to make an inference on z_{t-1} . From equation 12 and using the definition of ψ , we get

$$p_t \approx \left[1 + \psi \hat{\phi}_t + z_t \right] \bar{p}_t. \quad (16)$$

Taking logs:

$$\log p_t - \log \bar{p}_t \approx \psi \hat{\phi}_t + z_t \quad (17)$$

where the approximation $\log(1+x) \approx x$ for small x has been used. Moving the index for t back one period, we get the following formula for z_{t-1} :

$$z_{t-1} = \log p_{t-1} - \log \bar{p}_{t-1} - \psi \hat{\phi}_{t-1} + \eta_{t-1} \quad (18)$$

²⁹Throughout the section the emphasis is on current buyers and sellers. The results in the later counterfactual work suggest that potential buyers and sellers who choose not to be current buyers and sellers behave much more rational than the ‘current’ buyers and sellers.

where η_{t-1} is an error term, possibly for approximation error or mismeasurement.

The central assumption of the paper is now made. The idea is that when determining z_{t-1} households irrationally think that $\hat{\phi}_{t-1} = 0$.

Assumption 7. Current buyers and sellers assume that

$$z_{t-1} = \log p_{t-1} - \log \bar{p}_{t-1}. \quad (19)$$

This assumption implies that current buyers and sellers mistakenly interpret temporary price movements from search frictions as a permanent shock to the fundamental value to a house. This is the idea behind being ‘fooled by search’ in the title of the paper.

Using assumptions 6 and 7 in equation (17) we get

$$\log p_t - \log \bar{p}_t \approx \psi \hat{\phi}_t + \log p_{t-1} - \log \bar{p}_{t-1} + \varepsilon_t. \quad (20)$$

Noting that $\log \bar{p}_t - \log \bar{p}_{t-1} \approx \gamma$ (the trend growth in prices) and $\log p_t - \log p_{t-1} \approx \% \Delta p_t$ we can rewrite equation (20) as

$$\% \Delta p_t \approx \gamma + \psi \hat{\phi}_t + \varepsilon_t. \quad (21)$$

Equation (21) is the central equation that will be estimated for the ‘Irrational’ model.

6 Estimation of the Irrational Model

To estimate the irrational model rewrite equation (21) as

$$\% \Delta p_t \approx \gamma + \psi (\phi_t - \bar{\phi}) + \varepsilon_t. \quad (22)$$

Equation (22) is preferred to equation (21) since it does not depend upon the choice of $\bar{\phi}$. This distinction does not matter for the estimation of ψ , but it does for the errors ε_t . Equation (22) is estimated using standard OLS. The results are:

$$\psi = 1.9000 \quad \gamma - \psi \bar{\phi} = -0.1196.$$

The fit is shown in figure 7. The R^2 is 78.77%. This is quite a striking result. It states that over three-fourths of the annual movements in house prices are explained by turnover. Of course the model does not explain turnover, taking it as exogenous. However, it does create a test that any model of house prices needs to deliver: the strong relationship between turnover and house price growth.

7 Comparing Irrational and Rational Models

The irrational model predicts that turnover should affect price growth while the rational model predicts that turnover affects the price level relative to trend. The implication of

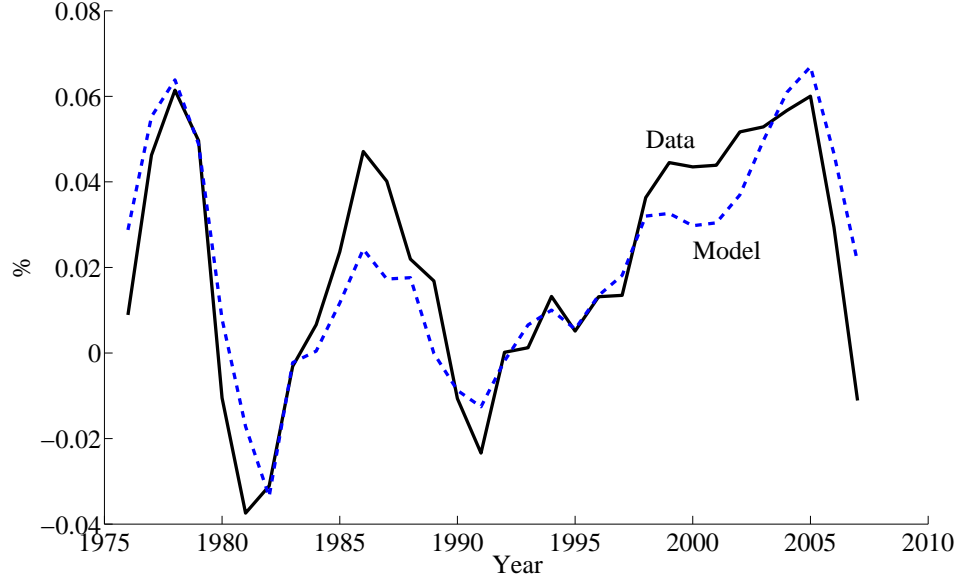


Figure 7: Annual Real House Price Growth, Data and Estimated Model. Data Source: OFHEO.

the irrational model is that turnover affects prices permanently while the rational model predicts that turnover only affects prices temporarily.³⁰ Therefore, the central question of this paper is: *which model fits the data better?*

To make this comparison define the fitted price growth from the irrational model as

$$\% \Delta p_t^{IM} = \gamma - \psi \bar{\phi} + \psi \phi_t$$

where the *IM* superscript denotes *Irrational Model*. The estimated price series can then be generated via

$$p_t^{IM} = (1 + \% \Delta p_t^{IM}) p_{t-1}^{IM}$$

and setting

$$p_{1975}^{IM} = 1.$$

The irrational price series is then detrended using the same estimate from the Rational Estimation section. The detrended prices series from the irrational and the rational models are shown in figure 8. The fit of the models, in terms of R^2 , is reported in table 1.³¹ Clearly the irrational model fits the data much better. We therefore get the main result of the paper:

³⁰All of these statements are assuming that future turnover is unaffected. The later counterfactual section shows that this is most likely not true.

³¹When calculating the R^2 the endpoints of the time series (1975 and 2007) are excluded since the irrational model is estimated in the deviations and matches the endpoints by assumption.

	Irrat. Model	Rat. Model: GMM	Rat. Model: OLS
R^2	80.35%	28.42%	43.94%

Table 1: The fit of the de-trended price level for the rational and irrational models.

Result 1. *Turnover is associated with permanent changes in prices rather than temporary.*

A way to reconcile such a result with theory is to assume:

Reconciliation 1. *Current Buyers and Sellers are affected by turnover when setting current prices, but ignore the effect of turnover on past prices.*

An implication of this reconciliation is that the change in the current price from current search frictions goes on to become a permanent change in prices as *future market participants* ignore that the current price change was caused by search frictions, in other words they are ‘Fooled by Search.’ The next sections generate some counterfactuals and interpret the estimated coefficient ψ . The counterfactuals will suggest that the choice of whether to enter the market seems to be influenced by the errors built up by market participants being fooled by search. Furthermore, the price setting in the decentralized market is terribly inefficient: buyers have a much higher weight in creating matches than they have in bargaining.

8 Alternative Rational Model

An alternative interpretation of the data is that the level of turnover is driven by the fundamental value of a house and that search frictions have little or no influence on prices. In fact there is probably not a way to distinguish such a model from the irrational model of this paper without a deeper theory. To see this, suppose that current sellers and buyers use past price and turnover data to figure out the deviation of fundamental value of a house from trend, z_{t-1} . Suppose the sellers and buyers believe that search frictions can affect prices. However, assume that the current sellers and buyers believe that the world is the rational model. This means that the sellers and buyers do not make assumption 7. Instead, the sellers and buyers use the rational estimation for z_{t-1} , putting equation (18) into equation (17), arriving at

$$\log p_t - \log \bar{p}_t \approx \psi \hat{\phi}_t + \log p_{t-1} - \log \bar{p}_{t-1} - \psi \hat{\phi}_{t-1} + \eta_{t-1} + \varepsilon_t \quad (23)$$

where the substitution $z_t = z_{t-1} + \varepsilon_t$ has been inserted. Using the log approximation $\log(1+x) \approx 1+x$ and using the definition of trend growth, γ , we arrive at

$$\% \Delta p_t \approx \gamma + \psi (\hat{\phi}_t - \hat{\phi}_{t-1}) + \varepsilon_t + \eta_{t-1}, \quad (24)$$

which is the rational version of equation (21).

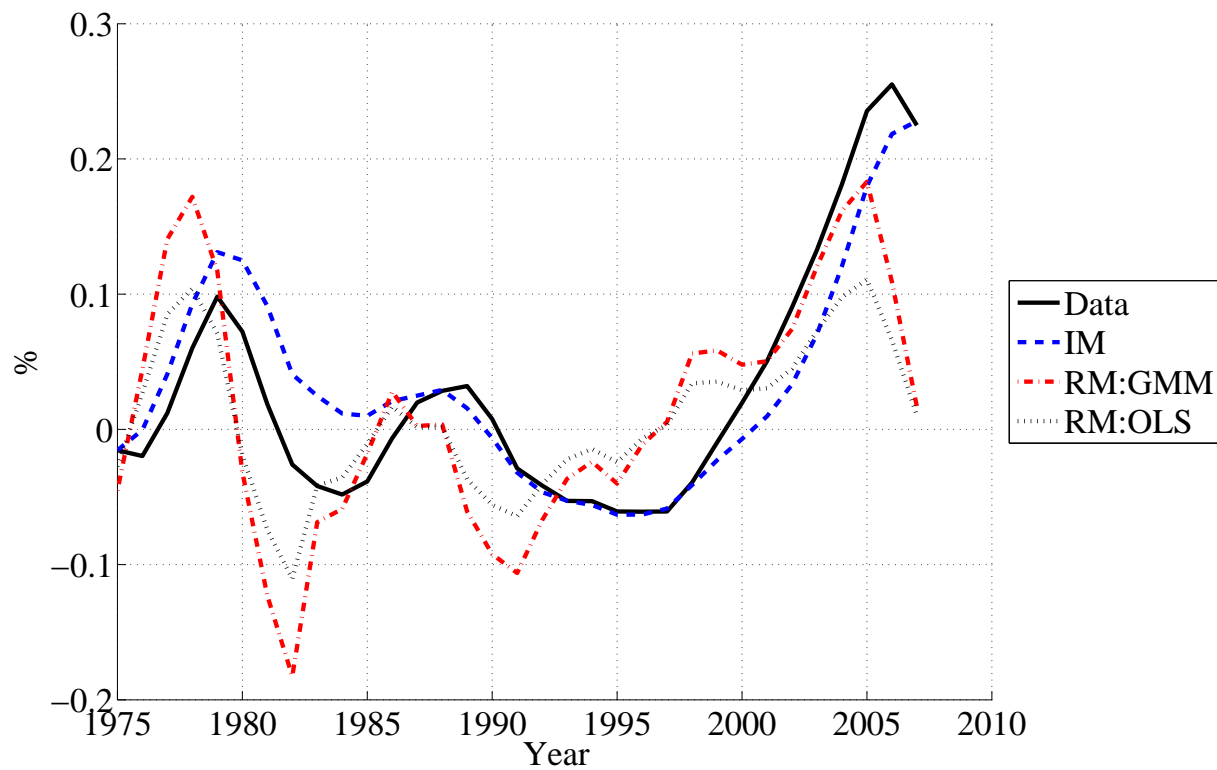


Figure 8: **Comparison of Estimated Models to Data** Annual Real House Price Growth, Data and Estimated Models. IM= Irrational Model; RM:OLS= Rational Model OLS Estimation; RM:GMM=Rational Model GMM Estimation Source: OFHEO.

In addition, assume that the sellers and buyers believe that the deviation of turnover from trend, $\hat{\phi}_t$, is proportional to the shock to the deviation of the fundamental value of house, ε_t . To make this assumption precise, suppose that

$$\hat{\phi}_t = \lambda \varepsilon_t + \nu_t. \quad (25)$$

Use equation 25 to substitute for ε_t in equation 24, arriving at

$$\% \Delta p_t \approx \gamma + \psi \left(\hat{\phi}_t - \hat{\phi}_{t-1} \right) + \frac{1}{\lambda} \hat{\phi}_t + \eta_{t-1} - \frac{1}{\lambda} \nu_t. \quad (26)$$

Equation 26 can be used to estimate the effects of search friction on prices, $\psi > 0$, and to determine whether turnover and the shock to the fundamental value of housing are correlated, $\lambda > 0$. The difference between equation (26) and the equation used in estimating the irrational model, equation (22), is the inclusion of a lag for turnover and a redefinition of the error term.

An OLS regression results in

$$\psi = 0.4522 \quad \text{and} \quad \lambda = 0.5527.$$

The fit of the Regression delivers an R^2 of 80.45%. The adjusted R^2 is 79.80%, an improvement over the 78.77% of the irrational model, but not by much.

The results imply that the high correlation between house price growth and turnover can be explained by turnover being correlated with shocks to the fundamental value of housing. This would imply that the irrational model was false because it was ignoring the correlation between ε_t and $\hat{\phi}_t$, and picked up $1/\lambda$ in the regression instead of ψ . Another result is the low value for ψ . The estimate here is only 0.45, while the irrational model estimated 1.90, a factor of over four difference. The standard deviation of $\hat{\phi}$ is only 0.013, so that the estimate of this section implies that a one standard deviation shock to turnover would only raise prices by 0.58%, whereas the irrational model estimate implies an increase of 2.45%.

There are then two competing interpretations of the data:³²

1. **Rational Interpretation** Search frictions have little or no effect on prices. The strong relationship between price growth and turnover is due to both price growth and turnover being driven by shocks to the fundamental value of housing.
2. **Irrational Interpretation** Search frictions do affect pricing. However, when current buyers and sellers set prices they ignore the effect of search frictions on past pricing, so that search frictions affect price growth rather than price levels.

Ultimately a deeper model and a deeper look into the micro data is needed to be able to distinguish between the two. One way to evaluate the different models is to analyze

³²Of possibly many interpretations.

the counterfactuals and other implications of the competing interpretations. This is done for the Irrational model in the next sections. First the implication of the estimate for ψ from the Irrational model is addressed, which turns out to depend upon the efficiency of the search process in the housing market.

9 Model Efficiency

A key feature of equation (21) from the Irrational model is that ψ determines how much prices move in response to high sales relative to supply. The formula for ψ is

$$\psi = \left[\frac{A}{r + A} \right] \frac{\omega}{\alpha} \frac{1}{\bar{\phi}}. \quad (27)$$

A key component of ψ is the ratio ω/α , the ratio of the buyer's weight in bargaining over the buyer's weight in producing matches. Those familiar with the search literature will recognize the importance of the ratio ω/α . As pointed out by Hosios (1990), when this ratio is unity, the model is efficient.

In search models, there is an externality from the search behavior of an agent. For instance, when a buyer³³ enters the market and starts searching, the buyer helps out sellers by raising the probability that a seller will make a sale, and hurts other buyers by lowering the probability that a buyer will be able to make a purchase. In the matching function, α denotes the weight of buyers in creating matches. When α is greater than a half, that means that an increase in buyers will cause a larger increase in sales than an increase in sellers. That is, α denotes the relative importance of buyers in creating sales, which affects the size of the externality created from a buyer entering the market.

The private return that a buyer gets from a match depends upon the bargaining weight ω . Specifically, the Nash Solution sets the surplus that a buyer gets from a match equal to ω of the combined surplus of a buyer and a seller to a match. When $\omega = \alpha$, the private return to a buyer from creating a match equals the societal return from a buyer entering the market. Therefore, in search models there is an inefficiency if $\alpha \neq \omega$.

We can use the estimate from the Irrational model to make an inference about ω/α . Rearranging equation (27) we get a formula for ω/α :

$$\frac{\omega}{\alpha} = \bar{\phi} \left[\frac{r + A}{A} \right] \psi. \quad (28)$$

In the model, sales over a time period of length Δ is given by

$$sales = \Delta \kappa \mu_O A \theta^\alpha,$$

where the assumption that the total amount of sellers is proportional to the owner stock via $\mu_S = \kappa \mu_O$ has been inserted. If we set Δ^A to be a year, then average annual turnover

³³Technically, a strictly positive measure of buyers in the model.

(annual sales over the owner stock) is given by

$$\bar{\phi}^A = \Delta^A \kappa A \quad (29)$$

where assumption 2 has been used setting $\bar{\theta} = 1$. In equation (28) the term $(r + A)/A$ is free from time units, so we can rewrite it for any time period, including Δ^A . Thus, rewrite equation (28) as

$$\frac{\omega}{\alpha} = \Delta^A \kappa A \left[\frac{r \Delta^A + A \Delta^A}{A \Delta^A} \right] \psi. \quad (30)$$

where the definition of $\bar{\phi}^A$ has also been used. Some rearranging results in

$$\frac{\omega}{\alpha} = \left(\kappa r^A + \bar{\phi}^A \right) \psi, \quad (31)$$

where r^A is the annual discount factor, $r^A = r \Delta^A$.

In the data $\bar{\phi}^A = 0.0717$, where once again the average is over the years 1976 to 2003. From the Irrational model estimates we get $\psi = 1.9$. Therefore conditional on values for κ and r^A we get

$$\frac{\omega}{\alpha} = (\kappa r^A + 0.0717) 1.9.$$

Using an annual discount rate of $r^A = 0.04$ and taking the strong stand that $\kappa = 1$ we get

$$\frac{\omega}{\alpha} = 0.2122.$$

This implies a very inefficient housing market with buyers bargaining weight being one-fifth of their weight on producing matches. Alternatively, we can ask what value for r^A reconciles efficiency in the search part of the housing market (again assuming $\kappa = 1$, an upper bound). This results in

$$r^A = 45.47\%.$$

This is a very high value. Of course it could be indicative of the very high impatience that buyers and sellers may have once they have decided to enter the market.³⁴ However increasing patience by a factor of ten seems a bit much.

To summarize, the Irrational model estimates imply that the search part of the housing market is inefficient by an order of magnitude. Buyers have a much higher weight on making matches than they do in the surplus from a match. The bargaining protocol has not been modelled in this paper. However, the results here indicate that sellers have an inefficiently high weight in the bargaining process. This could be indicative of a more complex model of incomplete information where buyers know market conditions better than sellers. It could also be for this heavy weight on sellers in the bargaining process that prices seem irrationally backward looking.

³⁴Throughout the whole paper the assumption has been that buyers and sellers have the same discount factor. Investigating a model with heterogeneity would be interesting.

10 Counterfactuals

The Irrational model is inefficient because current buyers and sellers interpret past price changes as a permanent change in the fundamental value of a house instead of temporary changes induced by temporary demand shocks and search frictions. In this section counterfactuals are constructed where buyers and sellers correctly take into account search frictions on past prices. Assume that buyers and sellers estimate z_{t-1} via

$$z_{t-1} = \log p_{t-1} - \log \bar{p}_{t-1} - \psi \hat{\phi}_{t-1}. \quad (32)$$

This is equivalent to dropping assumption 7. An implicit assumption in using this counterfactual is that turnover is not related to the fundamental value, z_t . In reality turnover probably moves in relation to z_t . With that in mind the results of this section should be thought of as an upper bound on the difference between the data and the counterfactual. Ultimately a model with endogenous turnover is desired. Nevertheless, the results of this section are quite enlightening.

To construct the counterfactual, subtract $\psi \hat{\phi}_{t-1}$ from the annual price growth in the data, or

$$\% \Delta p_t^{CF} = \% \Delta p_t - \psi \hat{\phi}_{t-1}, \quad (33)$$

where ‘CF’ denotes counterfactual. In constructing the counterfactual, a value for $\bar{\phi}$ must be used. In doing this, the same value is used as when constructing the trend in the estimation of the rational model, so that $\bar{\phi}$ is equal to the mean from 1975 to 2003. The counterfactual price growth is shown in figure 9. Inspection of figure 9 shows that price growth should have been less volatile. In addition, prices should have fallen earlier in the downturns and recovered earlier. In regards to the volatility, the standard deviation of price growth in the data is 2.79% while the standard deviation of the counterfactual is 2.29%. Therefore, the irrational inefficiency raises the volatility of annual real price growth by 21.56%.

10.1 The Housing Bubble

Of particular interest is the potential contribution of the irrationality assumption to the housing bubble of the past decade. In the introduction of the paper, figure 2 plots the counterfactual price path, the data, and a trend, beginning in 1998 where the 1998 real house price had been normalized to one. In the data, house prices peaked in 2006, after appreciating 45.26% since 1998. The counterfactual predicts that house prices should have peaked one year earlier in 2005, and that the peak should have been significantly lower, only peaking at an increase of 21.42%. Therefore, the irrationality assumption is responsible for an extra increase of house prices of 23.84%, or 52.67% of the housing bubble. If we take out the trend growth, the data peaks at 25.19% above trend, while the counterfactual peaks at 6.93% above trend. Relative to trend, the inefficiency can explain 72.48% of the housing bubble, almost three-fourths.

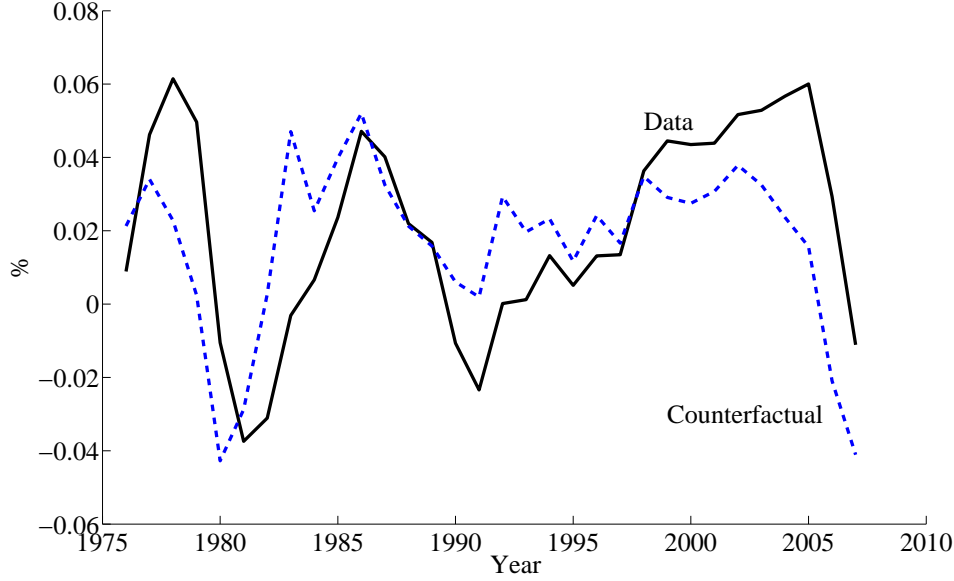


Figure 9: Annual Real House Price Growth, Data and Counterfactual from Estimated Model where the Irrational Assumption 7 has been removed. Data Source: OFHEO.

Note that this result is not explaining the housing bubble. No attempt has been made to explain the ultimate driving force, which is the increase in demand that shows up in higher turnover and higher prices. The model of this paper is an amplification device. The counterfactual states that given the increase in demand, house prices should only have increased by 6.93% in real terms relative to trend. The inefficiency, from ignoring search frictions on past prices, *magnifies* the effect of the increased demand on prices, resulting in prices rising an additional 18.26% relative to trend to reach the 25.19% increase relative to trend seen in the data.

The estimated shocks, ε_t , have some very interesting results over the housing bubble. To see this it is good to go back to 1988 and examine the counterfactual price path relative to trend. Figure 10 shows the detrended price path from data, turnover and some counterfactual price paths. The turnover series is deviations from the mean, re-scaled to be on roughly the same magnitude as the deviations from trend for the price data. The dashed blue line denoted ‘CF’ is the detrended counterfactual price path with assumption 7 removed. The last two lines marked ‘Eps’ and ‘Search’ break down the counterfactual into the part coming from the shocks, ‘Eps’, and the part coming from search frictions, ‘Search.’ The dotted (or vertical marks) black line, marked ‘Eps’, is the accumulation of the errors (since 1988) from equation (22) in the estimation of the irrational model—this would be the detrended counterfactual price path if turnover was held fixed at its stationary level. Last the dashed-dot blue line marked ‘Search’ is the detrended counterfactual price path with the irrationality assumption removed and the errors terms set to zero. This line would be

the price path from only the search frictions if households were rational. The sum of the ‘Eps’ line and the ‘Search’ line is equal to the ‘CF’ line.

Figure 10 tells an interesting story. First, turnover falls considerably preceding the 1990-1991 recession. This causes the data price path to start to decline relative to trend. The counterfactual price path also declines, but by much less. This is because the counterfactual price path should only be decreasing based upon the *change* in turnover, not the level, as it does in the data. Turnover bottoms out in 1991, but because it remains below trend, the price in the data continues to fall. However, as turnover rises after the bottom in 1991, the counterfactual price path starts to rise as turnover increases. But the price in the data keeps on falling, relative to trend, until 1997 when turnover finally gets back to its stationary level. From 1988 to 1997 the ‘Search’ price path is essentially the counterfactual price path. This is indicative of the ‘Eps’ price path essentially being zero over this time period, as it is.

Something quite interesting starts to happen in 1998. As turnover is starting to move above trend, the shocks, the ε_t s, start to go positive. This implies that prices are rising more than the model would predict, even though since turnover is above trend, prices are already rising at a fairly good clip. The accumulation of the ε_t can be interpreted as a permanent shock to the fundamental value of a house. This unobserved permanent shock to the fundamental of a house reaches its peak in 2003, and remains high until about 2005 (as shown by the ‘Eps’ line). After 2005 all of this fundamental shock is eroded and goes back to where it was in 1988.³⁵

This rise in the fundamental value to a house is quite intriguing. It seems to mirror quite well the ideas of a loose monetary policy beginning in 1998. This is consistent with the Federal Reserve under Greenspan not tightening enough at the end of the boom, and then keeping policy too loose in the recovery. Over this time period the counterfactual price path departs from the ‘Search’ counterfactual path. In fact, a rational search model would predict a fall in prices from the fall in turnover around the 2000 recession, however the counterfactual actually rises from the ε_t shocks. Furthermore, it is after the peak in the ‘Eps’ line that we see turnover really take off. In a rational model, the increase in turnover should have only caused a slight increase in the price level (since the ‘Eps’ line was also diminishing) as shown by the slight increase the counterfactual line. But to the contrary, the irrational model implies that that households take the temporary rise in turnover and treat it as permanent, so that as turnover remains high, prices keep on rising. In essence, the irrational assumption is an amplification effect that magnifies the effect of the loose monetary policy on house prices. It is the irrationality inefficiency that potentially makes the error in monetary policy be quite painful.

³⁵Note that the ε_t are from the whole estimation from 1976 to 2007, so there is no reason for them to necessarily sum to zero between 1988 and 2007.

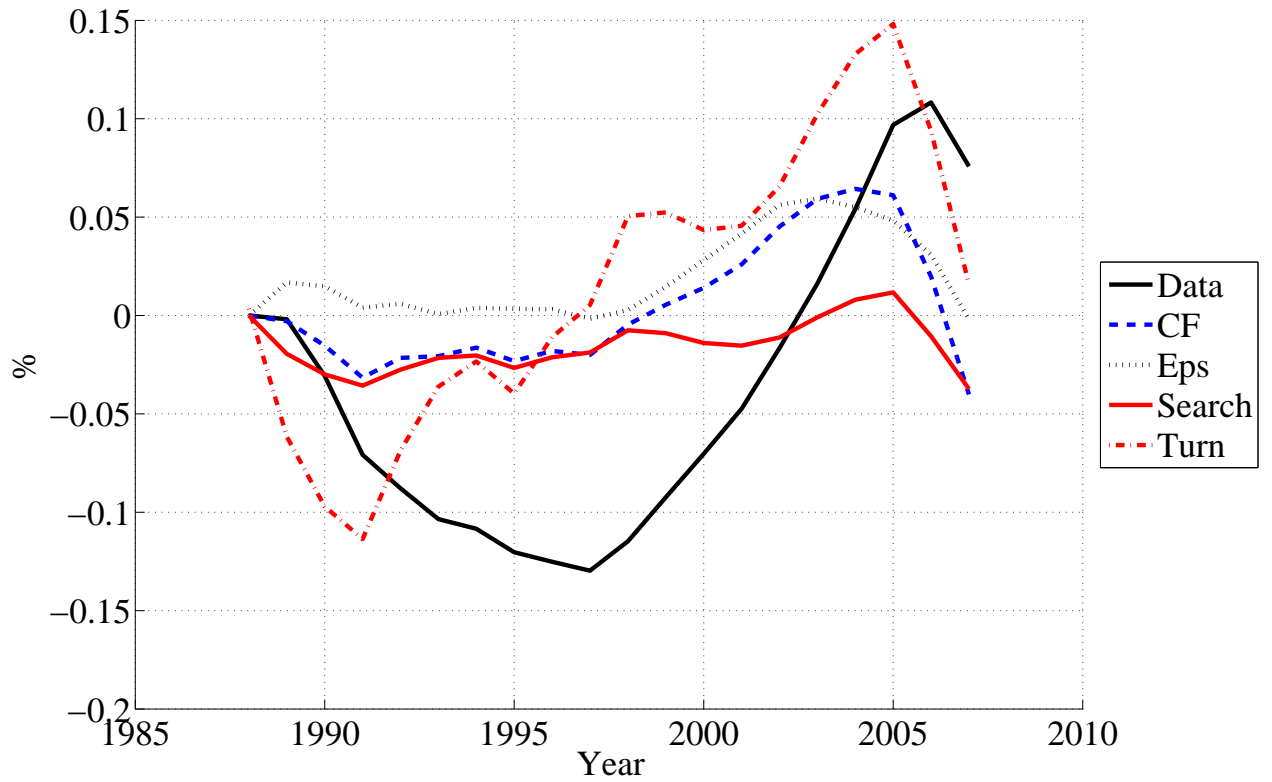


Figure 10: Detrended Real House Prices, Turnover (re-scaled deviations from mean), and Counterfactuals from Estimated Model where the Irrational Assumption 7 has been removed. For definition of different counterfactuals see the text; Source: OFHEO.

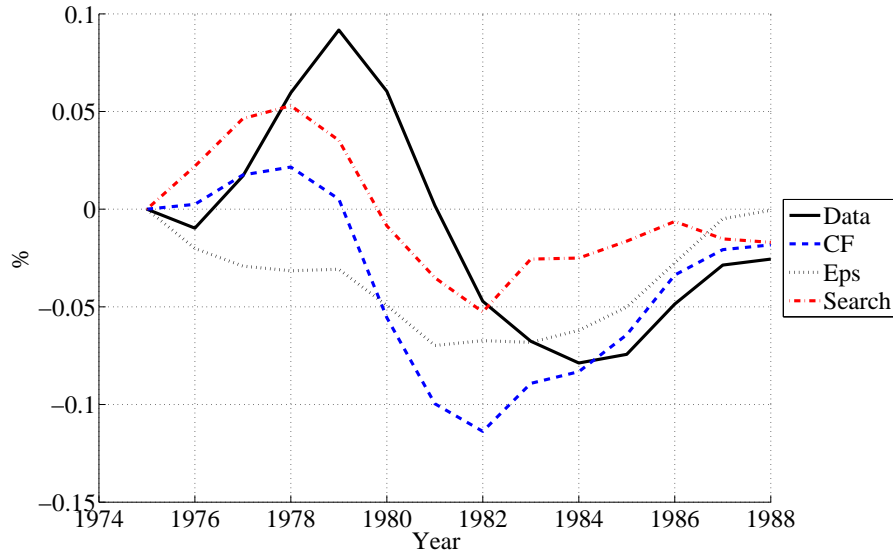


Figure 11: 1975-1988 Housing Cycle: Detrended Real House Prices, and Counterfactuals from Estimated Model where the Irrational Assumption 7 has been removed. For definition of different counterfactuals see the text; Source: OFHEO.

10.2 Boom and Bust of 1975-1988

From 1975 to 1988 there was a boom, bust and recovery of the housing market. Figure 11 plots the detrended data series and the counterfactuals. Once again we see that prices increased too much, illustrating the amplification effect from the irrational assumption. Of particular interest however is the behavior of the ‘Search’ counterfactual relative to the straight up counterfactual where the irrational assumption has been removed.³⁶ We see that these deviate from each other, with the search counterfactual implying prices higher than the standard counterfactual. The difference is due to the error terms. These are collected in the counterfactual ‘Eps.’ Notice that the ‘Eps’ line falls up to 1982 and then returns to zero by 1988.³⁷ This pattern seems consistent with stories of inflation expectation errors. From 1976 to 1982 inflation was rising, and then it started to fall.

Using the forecaster’s inflation expectations from the Philadelphia Federal Reserve, a series can be constructed of inflation forecast errors. The Philly Fed survey calculates a quarterly estimation of annual inflation expectations for the GDP Deflator. For instance, in the first quarter of 1974 the forecasters made a prediction for inflation for the next year,

³⁶Remember from the previous subsection that the ‘Search’ counterfactual is the counterfactual with the shocks removed, leaving only the movements from changes in turnover.

³⁷Once again, the error terms are estimated over the entire sample from 1976 to 2007, so they do not necessarily have to sum to zero from 1976 to 1988.

essentially a prediction for the change in the GDP Deflator between the first quarter of 1974 and the first quarter of 1975. Let the forecast error be the difference between the forecast and the realization. Precisely:

$$\pi_t^{err} = \pi_t - \pi_t^f \quad (34)$$

where π_t is the realized inflation at time t , π_t^f is the forecast of time t inflation (made one year before), and π_t^{err} is the forecast error. When the forecast error is positive, that means inflation was higher than expected. A higher than expected inflation will cause real prices to fall. Thus, in the estimation of the irrational model, if inflation is higher than anticipated, this would create negative errors. Figure 12 plots the accumulation of *negative* the inflation forecast errors up to time t , alongside the accumulation of the house price shocks, the ε errors from the estimation of the Irrational Model. The two series are almost on top of each other. There is just an issue with the timing of the forecast errors going from positive to negative. Therefore the difference between the counterfactual and the ‘search’ counterfactual in figure 11 can be explained by inflation forecast errors.³⁸ This implies that the relevant counterfactual is the ‘search’ counterfactual, not the straight up counterfactual that includes the error terms.

Using the search counterfactual as the relevant counterfactual delivers an interesting picture. Figure 13 shows the log real house price series and the search counterfactual, this time not detrended. The figure also plots turnover (recentered and rescaled to fit nicely on the picture). Initially the search counterfactual rises above the data—this is due to the inflation forecast errors. However, in 1978 the data catches up with the counterfactual and soars above it. This is the amplification device in the irrational model. Of interest however is the behavior of the turnover series. Once the house price in the data catches up the counterfactual, we see turnover fall. We then see the peak in the house price in the data and then a fall in house prices. In fact, real house prices keep on falling until the real price level is back at the counterfactual price level. We also see that turnover falls until the price in the data is driven down to the counterfactual price level. After the nadir in turnover, turnover and the counterfactual price level recover, while the price level in data lags behind in its recovery.

The story painted in figure 13 is quite informative. It suggests that the buyers who are thinking about whether to enter the housing market are quite rational. They seem to have a good understanding of the difference between the price level in the data and the counterfactual. Therefore, it seems to be just the *current* buyers and sellers who are

³⁸These results suggest that for making nominal price growth real, the relevant inflation measure should not be realized inflation but forecast inflation. In fact, using the inflation forecasts from the forecasters gives a much better fit for the Irrational model, raising the R^2 from 78.77% to 88.52%. This is also the subject of work under progress. In this model there are continuing inflation errors in the 1990s that have caused housing prices to be overvalued—inflation kept on coming in lower than expected, raising the price of housing relative to the GDP bundle. Brunnermeier and Julliard (2007) have focused on the effects of money illusion on housing bubbles. Their focus is not on houses being mispriced in decentralized trade, but rather on households not knowing the true inflation rate to calculate the user costs of owning a home.

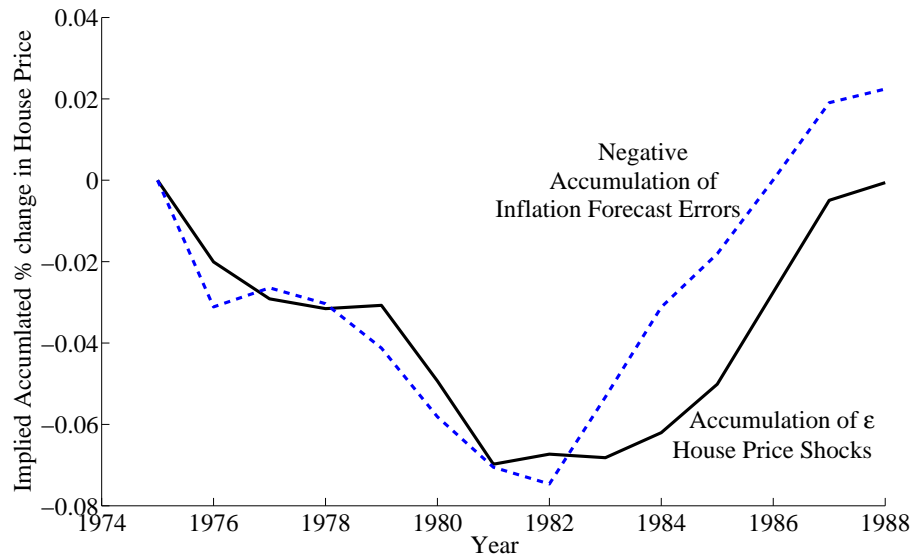


Figure 12: **1975-1988 Housing Cycle** Accumulated Estimation errors from the Irrational Model, ϵ , and *Negative* the Accumulated Inflation Forecast Errors from Professional Forecasters; Source: Philadelphia Federal Reserve Bank and BEA.

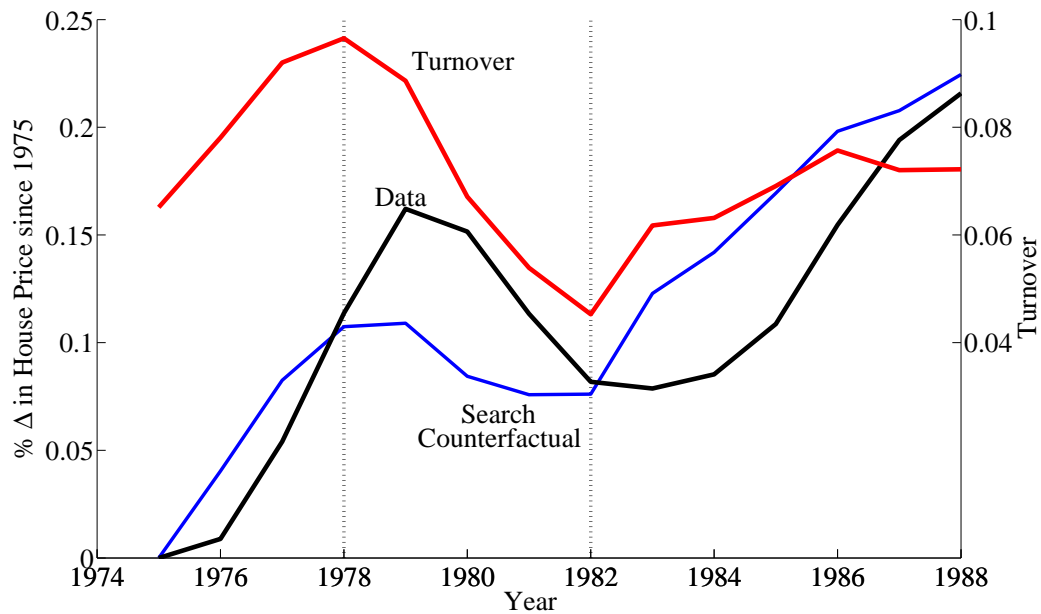


Figure 13: **1975-1988 Housing Cycle** Turnover (right scale), Log Real House Prices, and Search Counterfactual from Estimated Model where Assumption 7 has been removed. Source: OFHEO.

being irrational, and not the other potential buyers and sellers who are choosing to not be buyers and sellers. This could also be a function of sellers being the irrational ones but also having a lot of weight in the bargaining process. An implication of the 1975-1988 boom, bust and recovery is that turnover (and housing demand) keeps on falling until the real house price returns to the counterfactual. In addition, the housing price will also overshoot, falling too much below trend (or remaining flat in real terms as in the 1975-1988 episode). The next section uses this observation to make a statement about what can be expected about the depth and length of the current housing bust.

11 Projections for Current Housing Crisis

The results of the previous section can be used to make a projection for the size of the bust and eventual recovery in the current housing crisis. The previous section showed that the housing market did not start to recover until the real house price in the data fell down to the level of the counterfactual real house price. We can use this observation to think about what time series for turnover we can expect going forward in the current crisis. The idea is to find a path for turnover that drives the real price level in the data down to the real counterfactual price level. Figure 14 plots the percentage deviation of turnover from its long term level³⁹ for the 1982 crisis and the current crisis, where year zero is the peak of turnover for each housing boom. In addition the figure plots the percentage deviation for new home turnover for the current crisis.⁴⁰ We see very similar patterns for turnover.

A natural question to ask is whether the current crisis will be as bad as the 1982 crisis. To answer this question, going forward from 2008, set turnover equal to its value during the 82 crisis. This makes turnover in 2009 equal to the low point of the 82 crisis, or the year 4 in figure 14 and then it follows the 1982 path for the subsequent years. This path for turnover can then be fed into the model to make predictions for the real house price series in the data and for the counterfactual. The question being asked is: Can this path of turnover drive the real house price down to the counterfactual house price? The answer is negative, the price that the model predicts never reaches the predicted counterfactual price, the recovery happens too soon.

To give some idea of what type of path for turnover can drive the real house price down to the counterfactual, suppose that the percentage deviation in turnover falls down to the lowest level from the 1982 crisis, stays there from 2009-2011, and then follows the 1982 recovery. This roughly implies that the housing market stagnates for three years at the level of the nadir of the 1982 crisis. The forecasted price path and the forecasted counterfactual price path are shown in figure 15 along with a series for turnover that has been re-scaled and re-centered. This magnitude of a housing bust is able to drive the real housing price down to the counterfactual. Under this hypothesis, real house prices fall

³⁹The mean from 1976 to 2003

⁴⁰That is, new home sales over the owner stock of housing.

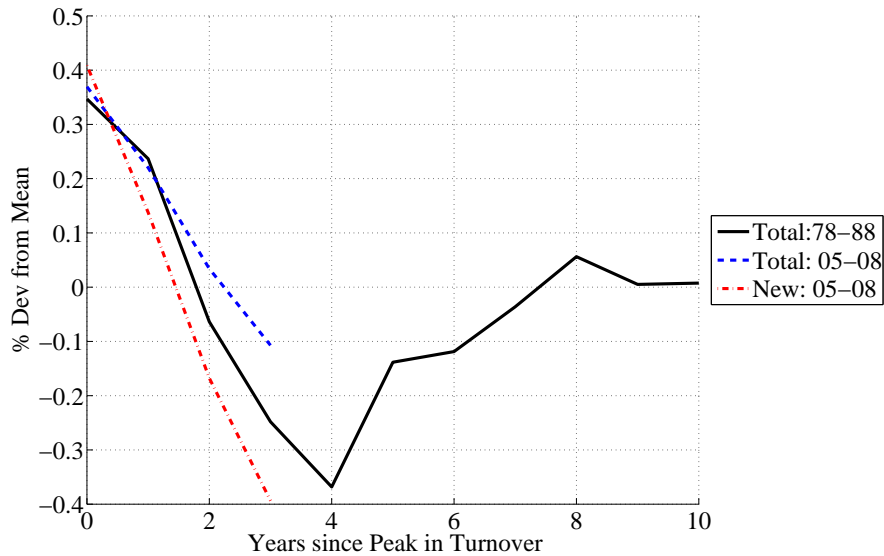


Figure 14: Turnover, percentage deviation from mean, years from peak of cycle for 1978 and 2005 housing bubbles. Source: NAR and Census.

until 2011. At that point real house prices will have fallen an additional 11% from their 2008 level and just over 15% from the peak in 2006, going back to the levels seen in 2002 and 2003. Of course this is the results for real prices. Nominal prices are probably more important, and that depends upon what happens to inflation or deflation in the coming years. The figure also marks the turning points in turnover. Notice how they line up with the dates when the house price in the data and the counterfactual cross.

The projections of this section imply quite rough times still to come for the housing market. The results from the counterfactuals in the 1975-1988 boom and bust suggest that turnover falls until real prices stabilize, and that prices recover very slowly. One way that turnover could recover more quickly is if prices fall more quickly that the estimates from the irrational model. Such a larger (downward) movement in prices would be bringing the housing market closer to the efficient market. This would also bring the real house price down to the counterfactual more quickly. Essentially, the quicker the house price can be brought in line with the counterfactual, the better. This is equivalent to trying to overcome the inefficiencies in the housing market that this paper has highlighted. Once the housing market is stabilized then the credit market can stabilize since the stabilization of the housing market would seem to be essential to stop the rising foreclosures.

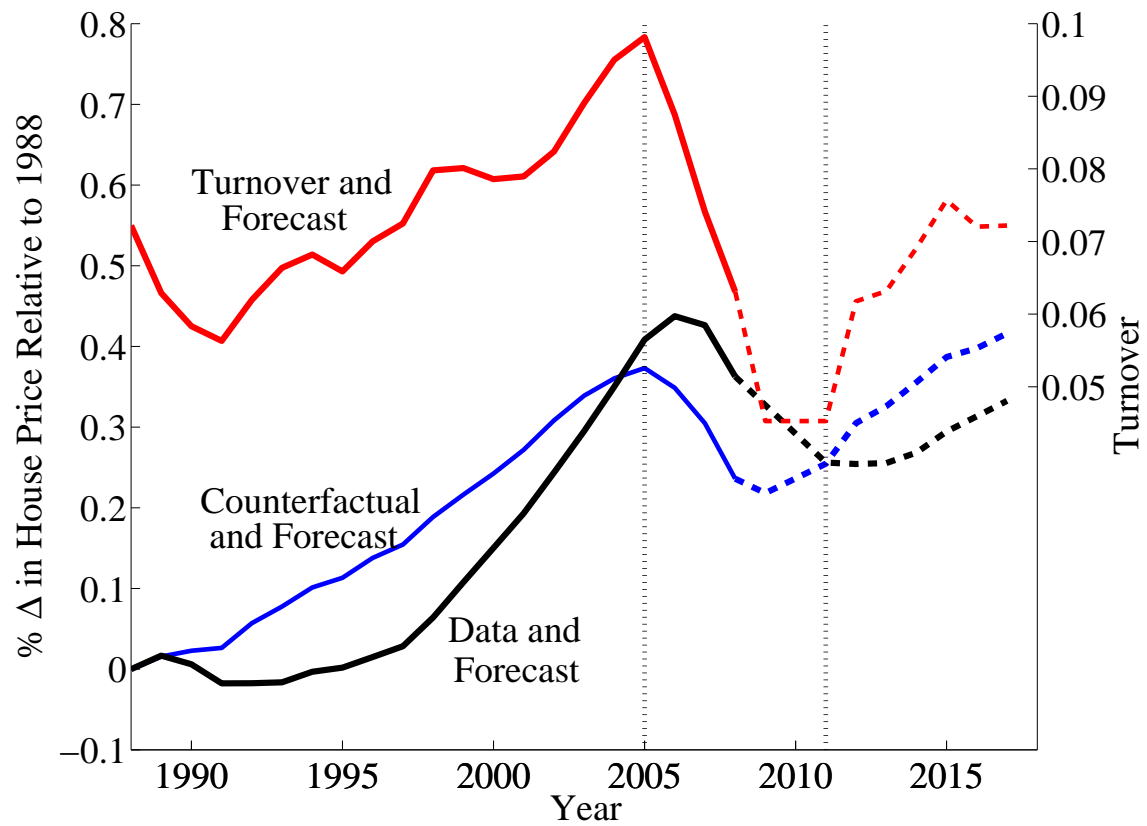


Figure 15: **Prediction for the Current Crisis in the Housing Market** Hypothetical paths for Real House Price and Counterfactual, assuming Turnover falls to the bottom of 1982 crisis for 2009-2011, and then follows 1982 recovery. Dashed lines are forecasts.

12 Conclusion

This paper has highlighted an observation from the data: in aggregate data for the United States Housing Market there is a very tight relationship between turnover and price growth rather than the price level. The significance between growth and levels is important since it is the distinction between a temporary movement in demand causing a permanent price change versus a temporary price change. One way to explain the data is to assume that movements in demand are related to permanent changes to the fundamental value of a house. However, if we believe that search frictions affect house prices, then we face a contradiction between theory and data: *theory predicts that the effects of search frictions on house prices from temporary movements in demand should be temporary, while the data suggests it is permanent.*

This paper has offered one possible resolution to the contradiction: *buyers and sellers ignore the effects of search frictions on past prices, instead interpreting all past prices as the best signal of the fundamental value of a house.* This behavioral assumption implies that when bargaining over house prices, current buyers and sellers (who are affected by search frictions) end up bargaining over price growth rather than the price level since they treat past prices as a type of anchor. The change in prices becomes permanent when future buyers and sellers interpret the change in prices as a change to the fundamental value of a house. In this way buyers and sellers are ‘fooled by search.’

Such a behavioral assumption seems related to Shiller’s observation that households have a very poor understanding of levels, dealing much better with the rate of change of prices. The assumption implies that a shock that raises demand causes an increase in the growth rate of prices, rather than an increase in the level of prices. If we accept Shiller’s hypothesis that there are positive feedbacks from growth rates, then shocks to demand (positive or negative) can cause further shocks to demand reinforcing the growth rate.

The behavioral assumption was inserted into a textbook search model, linearized, and estimated using standard OLS where each annual observation in the data was treated as a observation of the stationary continuous time model. The counterfactuals of the estimated model imply that over half of the increase of house prices during the housing bubble starting in 1998 can be explained by the amplification mechanism of search frictions and the ignorance of search frictions on past prices. When trend price growth is removed, the model explains almost three-fourths of the bubble.

The estimated model also implies that the search part of the housing market is inefficient (this is aside from the inefficiency from the behavioral assumption). Buyers do not have enough bargaining power relative to their contribution to creating matches. This suggests that buyers’ actions are responsible for sales, but when it comes down to negotiating, sellers have the power. This seems to follow most people’s understanding of the house market. This suggests reforms that allow sellers’ efforts to add to match creation and that limit the power of sellers in negotiation would improve the efficiency of the housing market.

The model of this paper takes turnover as exogenous and explains prices. Ultimately research should have both endogenous prices and turnover. However, the paper does provide guidance to explain turnover. There is evidence that buyers who are choosing to not enter the market do respond to the level. In the counterfactual of the estimated model, whenever houses are overvalued, turnover falls, while when houses are undervalued turnover is increasing. This suggests that renters who are thinking about entering the housing market are affected by levels, consistent with down payment stories. A model that combines the amplification mechanisms in Stein (1995) and Ortalo-Magné and Rady (2006), search, and renters that face down payment constraints seems quite intuitive. The tight correlation between price growth and turnover would then serve as a benchmark for a model to hit.

The estimated model also provides evidence that there was an increase in the fundamental value of houses starting in 1998, rising through 2003-2005, and then falling back down to the pre-1998 levels by 2007. This seems quite consistent with stories of loose monetary policies under Greenspan. In fact the author remembers how everyone started really thinking about getting into housing when the Federal Reserve lowered rates in reaction to the 1998 Asian Crisis. Any effect this had on turnover, would create an amplification on prices if we accept the assumptions of this paper. This implies much larger effects from monetary policy on prices than just the channel of interest rates on the fundamental values of houses. In fact, the effect of demand on the growth rate of prices could lead to ‘Irrational Exuberance.’

More work needs to be done to examine how pervasive the relationship between price growth, price levels, and turnover is. Specifically, the results at the regional, metropolitan, and in other countries are needed. What is significant is whether a measure of a sales rate is related with price growth or price levels.

To finish up, if we accept the assumptions of this paper, own way to get around the inefficiency from the behavioral assumption would be to create price indices that *take out* the change in house prices that is due to a combination of changes in market tightness and search frictions.⁴¹ Such an index would be model specific, but could better inform the public to better price illiquid real assets that trade in decentralized markets, such as houses. This could help to mitigate ‘Irrational Exuberance.’

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⁴¹Note that such an index is different from the proposals of Fisher, Gatzlaff, Geltner and Haurin (2003) and Goetzmann and Peng (2006). Their proposals are to add the increase in liquidity to the price level. The underlying model in their framework is one where bargaining between buyers and sellers, and hence prices, does not respond to changes in liquidity. This would create larger swings in prices. My proposal would be to take out the swings in prices that are due to prices responding to liquidity.

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